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The principal features of the Sun-spot record for 1894, as brought out by the above tables, are :—

(1) A definite decrease in the mean daily areas of whole spots as compared with 1893 is shown, though this area was greater in 1894 than in 1892, and considerably greater than in 1883, the year of maximum in the preceding cycle.

(2) Faculæ have diminished in a yet higher ratio ; the decline in their case having set in strongly in 1893, a year earlier than with the spots, and having continued throughout 1894.

(3) Umbræ have shown hardly any decrease as compared with 1894.

(4) The decline as to whole spots has been limited to the southern hemisphere, the northern showing a slight recovery.

(5) But the southern hemisphere still remains the predominant one.

(6) Little change has taken place in the mean distribution of the spots in heliographic latitude, but the general trend of movement is still towards the equator.

(7) There is a slight reversal of this trend for the southern hemisphere considered separately, due chiefly to the great outburst of February 16 to March 1 in latitude $-32°$; but the movement towards the equator is very marked for the northern hemisphere.

(8) It may be added that no day in 1894 showed the Sun entirely free from spots.

Photographic Stellar Spectra of the Variable Star β Lyræ, and also of Types III. and IV. By F. McClean, M.A., LL.D., F.R.S.

The exceptional phenomena revealed in the spectrum of the variable star *β Lyræ* are well known, and hypotheses have been framed to account for them by Pickering and others.

The series of comparative photographs which accompany this paper (Plates 1 and 2) show distinctly the periodic variations of this spectrum. They extend from H_β to H. The negatives were taken during the autumn of 1895.

Pickering in 1891 identified the spectrum with hydrogen and the *Orion* stars. Lockyer in 1894 attributed the absorption spectrum to two stellar components, one resembling *Rigel* and the other *Bellatrix*. He found that the bright lines and the *Bellatrix* lines were displaced in the same direction, but not to the same extent.

On comparing the spectrum of *β Lyræ* with the spectra of other Helium stars, it appears that the nearest approach to it is the spectrum of *ζ Tauri*. The spectrum of this star has

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therefore been mounted in conjunction with the series of β *Lyræ*. It will be seen that with small exceptions the whole of the principal absorption lines in the two spectra correspond. These lines also correspond, almost line for line, with the principal lines in the same portion of the spectrum of Clevèite Gas as determined by Runge and Paschen (*Astrophys. Journ.* Jan. 1896, see Note 2). The hydrogen lines and the K line are superadded. The absorption line, which appears most distinctly to shift its relative position, is the Helium line at w.l. 3964, close to H_ϵ. The curious effect of displacement and doubling seen in the Helium line at w.l. 4472 appears to be due to the alternate obscuration of this line and the adjacent iron (?) line at w.l. 4482, by the shift of the corresponding diffuse emission Helium line at w.l. 4472.

In mounting the photographs, the whole of the relative displacement has been given to the bright line spectrum, but of course this need not be the case. It appears, on the whole, as if the diffuse bright lines of the emission spectrum corresponded with the hydrogen lines and the principal Helium lines of the absorption spectrum.

On the seventh and the thirteenth days the two spectra appear nearly to correspond in position. At other times, from the thirteenth to the seventh day, the bright-line spectrum is displaced towards the red, and from the seventh to the thirteenth day towards the violet. There are however discrepancies in this general effect which it is difficult to reconcile.

The systematic classification of stellar spectra was established by Father Secchi in 1866 and 1867. The photographs which accompany this paper are included in his Types III. and IV. Stellar spectra of these types have been thoroughly investigated by Huggins, Dunér, Vogel, Lockyer, and others. Dunér's celebrated Memoir forms an exhaustive treatise on the subject.

The banded portions of these spectra, called "Dunér's Bands," are distinctly shown.

The photographs of Type III., in addition to the bands, show line absorption spectra in nearly all respects identical with Type II. (the solar type).

There is increased general absorption in the violet, and various groups of lines, due to calcium, manganese, and other substances, are intensified. The general character of the spectrum remains unchanged. The bands supervene gradually, and some of them can be recognised in spectra of Type II. The crucial band appears to be Band No. 5, which is only present in the characteristic spectra of this type. This band appears faintly on the transitional spectrum of α *Tauri* (*Aldebaran*), and the manner in which it there supervenes on the spectrum of Type II. appears to preclude the possibility of the adjacent bright band being other than an effect of contrast. The practical identity of the line absorption spectra of Types II. and III. indicates that the

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transition from one to the other is due to the natural course of change in the condition of the stars themselves.

The stars of Type IV. are mostly below the 6th magnitude. Two different photographs are given of the star 152 Schjellerup of the $5\frac{1}{2}$ magnitude. This is Secchi's "Superba." Two hours' exposure was required, which accounts for the exaggerated distortion due to the changing amount of refraction during exposure. The value of the faint details is enhanced by the correspondence of the two photographs. The presence of a line absorption spectrum is distinctly shown, and it appears to agree to a marked extent with the usual line spectrum of Types II. and III. There appears to be no trace of Dunér's Band, No. 5 of Type III. The inference seems to be that spectra of Type IV. arise from a natural course of change in these stars, passing directly from Type II. They are stars of Type II. become less luminous, but not different in kind.

It is well known that the "Dunér Bands" of Type IV. are due to the absorption of hydrocarbon, being the reverse of the emission spectrum of hydrocarbon gas.

Notes.

Note 1.—Photographs of β *Lyræ*.

		d	h			d	h
No. 1 from min.		0	6	No. 7 from min.		7	0
2	„	1	1	8	„	8	0
3	„	2	19	9	„	8	5
4	„	4	1	10	„	8	21
5	„	5	0	11	„	11	2
6	„	6	0	12	„	12	2

Comparison spectra, β *Orionis* and ζ *Tauri*.

Note 2.—Principal lines in the spectrum of clevèite gas, from H_β to H_ζ Runge and Paschen, *Astrophys. Journ.* 1896 Jan. Lines of intensity 1 omitted.

Wave length		3889.	Intensity 10	Wave length		4144.	Intensity 2
„	„	3965.	„ 4	„	„	4388.	„ 3
„	„	4026.	„ 5	„	„	4472.	„ 6
„	„	4120.	„ 3	„	„	4713.	„ 3

Note 3.—Secchi, *Comptes Rendus*, 1866 Octobre 8; *Memorie della Società Italiana*, 1867, 1868.

Note 4.—Stellar spectra of Type III.—*o Ceti* (showing bright lines, H_γ and H_δ), α *Tauri*, α *Orionis*, α *Scorpii*, β *Andromedæ*, α *Ceti*, δ *Ophiuchi*, μ *Geminorum*, δ *Virginis*, β *Pegasi*, α *Herculis*. Not included, γ *Eridani* and μ *Ursæ Majoris*.

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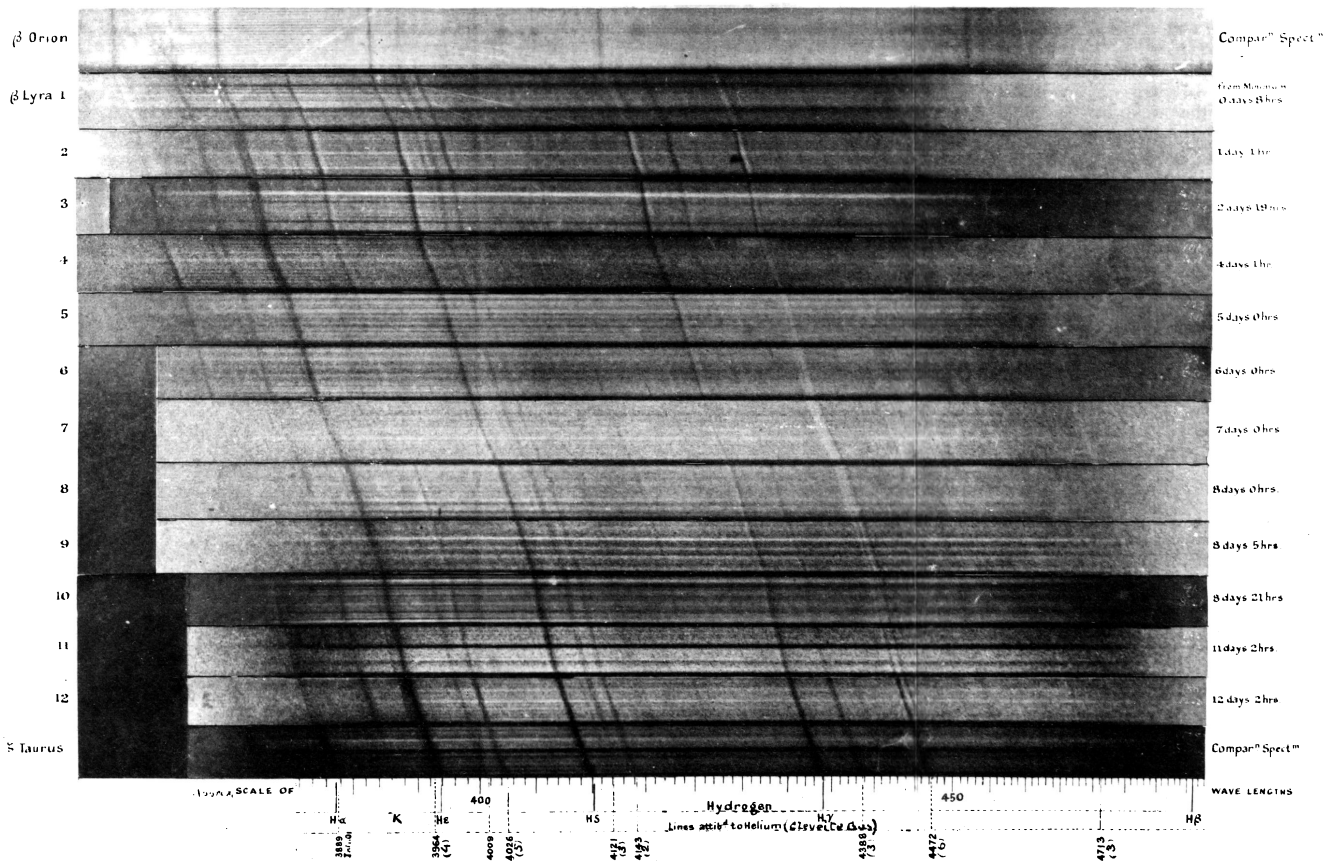
PHOTOGRAPHIC SPECTRA OF VARIABLE STAR β LYRA.

Magnitude 3 to 4. Period 12 days 22 hours. Secondary Minimum 6 days 11 hours.



Note. *The inclination of the lines is caused by varying Refraction (due to varying Altitude) during Exposure.*

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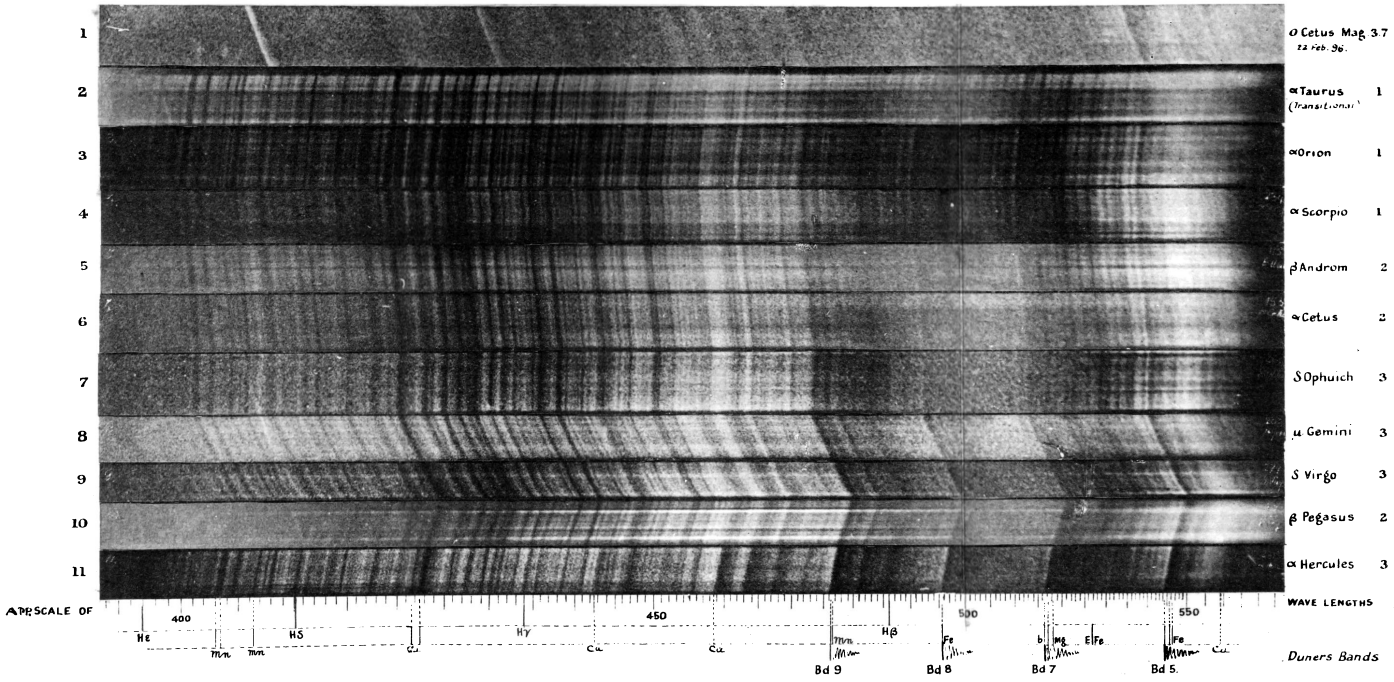
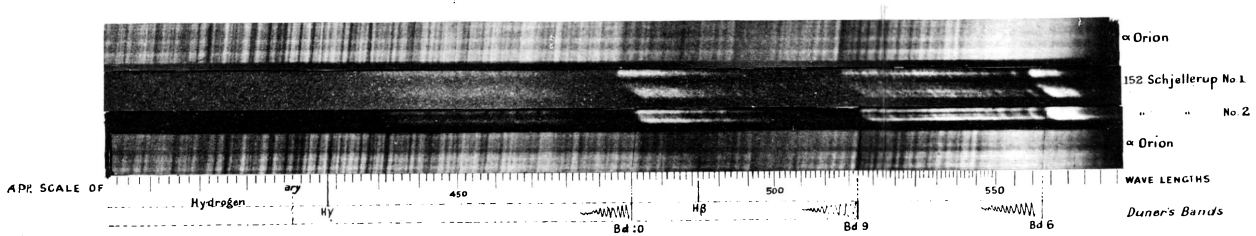
PHOTOGRAPHIC STELLAR SPECTRA OF TYPE III.



PHOTOGRAPHIC SPECTRUM OF SECCHI'S TYPE IV



Note. The inclination of the lines is caused by varying Refraction (due to varying Altitude) during Exposure.

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